EMOTIONAL AND CARDIOVASCULAR RESPONSES TO COUPLE CONFLICT IN POSTTRAUMATIC STRESS DISORDER: A STUDY OF OPERATIONS ENDURING AND IRAQI FREEDOM VETERANS AND PARTNERS

by

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A dissertation submitted to the faculty of
The University of Utah
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Psychology

The University of Utah

August 2013

The University of Utah Graduate School

STATEMENT OF DISSERTATION APPROVAL

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ABSTRACT

Posttraumatic stress disorder (PTSD) is associated with increased risk for cardiovascular disease and relationship difficulties. Greater exposure to couple conflict, and greater emotional and cardiovascular reactivity to such conflict, may help explain the link between PTSD and cardiovascular disease in veterans. Male veterans of Operations Enduring and Iraqi Freedom and their female partners participated. There were 32 couples in which the veteran had PTSD, and 33 control couples (veterans' age $M = 33.7$, $SD = 7.4$; partner's age $M = 31.6$, $SD = 8.2$; 92.3% Caucasian). Veterans completed the Clinician Administered PTSD Scale and the PTSD Checklist. All participants completed the Structured Clinical Interview for the DSM-IV-TR; Marital Satisfaction Inventory-Revised; Depression, Anxiety, and Stress Scale; and state anger and anxiety scales. Blood pressure and impedance cardiography were recorded throughout a conflict discussion. Compared to control couples, PTSD couples reported greater psychological distress, couple conflict, and disaffection (low warmth), and larger increases in anger in response to conflict. PTSD couples also displayed greater increases in systolic blood pressure and cardiac sympathetic activation in response to the stressor (all ps $< .05$; range η^2: .066-.074). Partners in the PTSD group exhibited similar, if not greater, increases in negative affect and physiological responses as veterans with PTSD. This is the first investigation to document emotional and cardiovascular risks of couple conflict in veterans with PTSD

and their partners. Anger and physiological responses to couple discord might be pathways linking PTSD to health risks, for both veterans and their partners.

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INTRODUCTION

Of the 2 million troops from the United States deployed to the Operation Enduring Freedom (OEF; Afghanistan) and Operation Iraqi Freedom (OIF; Iraq) theaters since 2001 (Institute of Medicine, 2010), up to 25% return with signs of posttraumatic stress disorder (PTSD; Seal et al., 2009). Annual healthcare costs associated with PTSD in OEF/OIF veterans are 4 to 6 billion dollars (Cohen et al., 2010), much of which is due to physical health problems other than trauma-related physical injuries (Hoge, Terhakopian, Castro, Messer, & Engel, 2007). Cardiovascular disease (CVD) is an important health problem in this regard, and includes hypertension, coronary heart disease, and stroke. Individuals with PTSD are at increased risk for CVD, compared to civilians or veterans without PTSD (Boscarino, 2008; Kubzansky, Koenen, Spiro, Vokonas, & Sparrow, 2007).

PTSD is also associated with couple discord, especially in military as compared to civilian populations (Taft, Watkins, Stafford, Street, & Monson, 2011). Marriage itself generally reduces the risk of physical health problems, including CVD (Holt-Lunstad, Smith, & Layton, 2010), but couple *conflict* and disruption (i.e., separation, divorce) have been linked to increased risk for the development and poorer prognosis of CVD (De Vogli, Chandola, & Marmot, 2007; King & Reis, 2012; Matthews & Gump, 2002; Smith, Uchino, Berg, & Florsheim, 2012a).

Couple conflict and strain may contribute to CVD through cardiovascular

reactivity (CVR) during stressful couple interactions, specifically increases in heart rate and blood pressure (Chida & Steptoe, 2010; Nealey-Moore, Smith, Uchino, Hawkins, & Olson-Cerny, 2007; Smith et al., 2009). Couple strain is associated with other physiological mechanisms implicated in the development of CVD, such as neuroendocrine responses, inflammatory factors (Robles & Kiecolt-Glaser, 2003), and reduced parasympathetic functioning (Smith et al., 2011). Hence, PTSD might confer risk for CVD – at least in part - through increased exposure to couple conflict and heightened physiological reactivity during such conflicts. To date, no study has investigated this psychophysiologic mechanism in military couples.

Prior research on couple processes and PTSD has relied on single dimension models and measures of relationship quality, such as general relationship satisfaction (Taft et al., 2011). However, two broad dimensions of disaffection (i.e., low warmth, positivity) and disharmony (i.e., high conflict, negativity) contribute to relationship distress, and are independently related to overall relationship adjustment and related outcomes (Herrington et al., 2008; Mattson, Paldino, & Johnson, 2007). Thus, in examining the associations of PTSD with couple processes, it would be useful to include measures of these more specific aspects of close relationships.

Anger may be a common factor linking PTSD and couple difficulties with CVD risk. PTSD is strongly associated with anger and related emotional problems (McHugh, Forbes, Bates, Hopwood, & Creamer, 2012; Orth & Wieland, 2006), and anger and aggressive behavior are prevalent in OEF/OIF veterans with PTSD (Jakupcak et al., 2007). Higher levels of anger and hostility are associated with increased couple difficulties in civilian populations (Baron et al., 2007; Renshaw, Blais, & Smith, 2010),

as is the experience of anger during couple interaction (Sanford, 2007). These affective symptoms have also been linked to couple discord in PTSD and military populations (e.g., Rodrigues & Renshaw, 2009). Importantly, veterans' PTSD-related anger is associated with greater relationship distress not only for veterans themselves, but also for their spouses (Monson, Taft, & Fredman, 2009; Renshaw, Blais, & Caska, 2011).

Anger, hostility, and aggressiveness are also associated with increased risk of CVD (Chida & Steptoe, 2009), again perhaps through the mechanism of heightened CVR (Chida & Steptoe, 2010). Along the same lines, PTSD is associated with greater cardiovascular reactivity to anger-related stressors (e.g., recalling angry memories) (Beckham et al., 2002). Hence, the extent to which PTSD confers greater susceptibility to heightened CVR and anger during potentially stressful couple interactions is an important question for research, with implications for both the health consequences of PTSD and the management of related couple difficulties.

Finally, PTSD in veterans is also related to emotional distress in their spouses, typically in the form of anxiety, depression, and burden (Caska & Renshaw, 2011; Lambert et al., 2012). Given this distress, these relationship partners may also be at risk for increased negative affective and physiological responses to couples-based stressors. However, no investigations to date have examined this hypothesis. Some studies find that such conflict evokes larger cardiovascular and affective responses in women than men (Kiecolt-Glaser & Newton, 2001; Smith, Uchino et al., 2012b). This suggests that the female partners of male veterans with PTSD may display particularly large responses to stressful couples interactions. If so, these partners may represent a large, but currently unidentified, group at increased risk for health-related difficulties.

Toward these ends, the present study examined OEF/OIF male veterans' and female partners' emotional and physiological responses to couple conflict, comparing couples in which veterans had or did not have military-related PTSD. We evaluated CVR (i.e., systolic and diastolic blood pressure; heart rate) and changes in negative affect (i.e., anxiety, anger) during a discussion of a recent and on-going relationship problem. We hypothesized that, compared to control couples, veterans with PTSD and their partners would display greater CVR and increases in negative affect – especially anger – in response to this task.

Beyond the traditional measures of CVR, we examined sympathetic and parasympathetic functioning at rest and in response to couple conflict. PTSD has been associated with alterations in resting (i.e., baseline) autonomic functions and stressor-related reactivity (Friedman, 2007; Hauschildt, Peters, Moritz, & Jelinek, 2011). Cardiac preejection period (PEP) provided an index of sympathetic functioning, and high frequency heart rate variability (hf-HRV), often termed respiratory sinus arrhythmia, provided an index of parasympathetic activity (Thayer, Hansen, & Johnsen, 2008).[1] Sympathetic activity has an obvious role in anxiety and stress (e.g., Young, Abelson, & Liberzon, 2008), and parasympathetic functioning is attenuated in anxiety disorders generally (Friedman, 2007) and in PTSD in particular (Hauschildt et al., 2011). Moreover, low parasympathetic activity is associated with increased risk of CVD (Thayer & Lane, 2007), and has recently been implicated in couple discord (Smith et al., 2011). Finally, we also examined associations of PTSD with both general couple distress and the more specific measures of disaffection and disharmony. We predicted that veterans with

[1] Changes in cardiac output (CO) and total peripheral resistance (TPR) were also examined as potential determinants of systolic and diastolic blood pressure reactivity.

PTSD and their partners would report greater overall couple distress, disharmony (i.e., conflict), and disaffection.

METHOD

Participants

A total of 65 male veteran/female partner couples participated. Veterans had deployed an average of 1.5 times (*SD* = 0.64) to the OEF/OIF theaters since 2001. Of these couples, 32 met eligibility criteria for the PTSD group. Those veterans' ages ranged from 24 to 53 (*M* = 32.7; *SD* = 7.6), 94 % were Caucasian, and none identified as Latino/Hispanic. Partners' ages ranged from 19 to 49 (*M* = 31.1; *SD* = 8.2), 84% were Caucasian, and 14% self-identified as Latina/Hispanic. Most of couples in the PTSD group were married and living together (84%); the others were living together and unmarried. Married couples were married an average of 6.6 years (*SD* = 5.8), and unmarried couples had lived together for an average of 2.3 years (*SD* = 2.4).

A total of 33 couples met eligibility criteria for the control group. Those veterans' ages ranged from 23 to 49 (*M* = 34.7; *SD* = 7.3), 97% were Caucasian, and 3% were Latino/Hispanic. Partners' ages ranged from 21 to 47 (*M* = 32.1; *SD* = 8.1), 94% were Caucasian, and 10% self-identified as Latina/Hispanic. All couples in the control group were married (*M* = 9.0 years; *SD* = 7.3) and living together. Additional descriptive information is presented in Table 1. Statistical control of the small group differences in veterans' education levels and the length of time that the couple had lived together did not alter any of the results reported below.

Couples were excluded from both groups if either the veteran or partner had a history of major CVD (e.g., stroke, CHD) or were taking medications that would alter CVR (e.g., beta-blockers). Additional exclusion criteria included the presence of active suicidality, homicidality, mania, psychosis, and/or alcohol/drug dependence within the last three months. All veterans in the PTSD group met at least subclinical criteria for PTSD, according to interview and self-report measures as described below. Veterans in the PTSD group were not excluded for the presence of other Axis I psychiatric diagnoses, considering the high rates of comorbidity for PTSD (Pietrzak, Goldstein, Southwick, & Grant, 2011). However, veterans in the control group were excluded for the presence of PTSD or any other current Axis I disorder. Moreover, partners in both groups were excluded if they met criteria for current PTSD related to their own trauma prior to and unrelated to the veteran's trauma. Partners experiencing PTSD-like symptoms in relation to the combat veterans' deployments or his PTSD symptoms were not excluded. Despite efforts, we were unable to recruit eligible female veteran/male partner dyads for either group.

Measures

The **Clinician Administered PTSD Scale** (CAPS; Blake et al., 1995a) is a 30-item structured interview that evaluates the 17 PTSD symptoms outlined in the DSM-IV-TR (American Psychiatric Association, 2000), and has been well validated (Weathers, Ruscio, & Keane, 1999). Trained graduate student interviewers administered the CAPS to veterans, supervised by a licensed clinical psychologist. A random subset (20%) of audiotaped interviews was independently rerated to determine the interrater reliability of the presence vs. absence of a PTSD diagnosis, according to DSM-IV-TR criteria. The

interrater reliability for the CAPS was found to be Kappa = .83 ($p < .01$).

The **Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version**, Patient and Non-patient Edition (SCID; First & Gibbon, 2004) is a widely used and well-validated structured interview that was administered to both veterans and partners by trained graduate student interviewers. PTSD group veterans completed the patient edition and all other participants completed the nonpatient edition, focused specifically on current Axis I psychological disorders. Twenty percent of SCID-I interviews were rerated by interviewers, and Kappa estimates for agreement among disorder categories ranged from .74 – 1.0 (all *p*s < .05).

The **PTSD Checklist** (PCL; Weathers et al., 1993) is a widely used and well-validated (Keane, Street, & Stafford, 2004) 17-item, Likert-type, self-report assessment of the DSM-IV criteria for PTSD (American Psychiatric Association, 1994). Participants responded to the questions in regard to the past month. Veterans completed the military version (PCL-M), which was used as a measure of PTSD symptom severity in relevant analyses. A cutoff score of ≥ 35 was required for inclusion in the PTSD group and ≤ 29 for inclusion in the control group (Bliese et al., 2008). Partners completed the civilian version (PCL-C) regarding descriptions of stressful military experiences reported by the veteran.

The **Mississippi Scale for Combat-Related Posttraumatic Stress Disorder** (MSCRP; Keane, Caddell, & Taylor, 1988) is a 35-item, Likert-type, well-validated (Keane, Street, & Stafford, 2004) measure of combat-related PTSD, designed to assess DSM-III criteria for PTSD (American Psychiatric Association, 1980). This measure was

completed by veterans and used as an independent classification test of PTSD symptoms in the PTSD vs. control groups.

The **Depression Anxiety Stress Scale** (DASS; Lovibond & Lovibond, 1995) is a 42-item, Likert-type, self-report measure that was completed by both veterans and partners, rating symptoms over the past week, on a scale from 0 (*did not apply to me at all*) to 3 (*applied to me very much* or *most of the time*). The depression and anxiety subscales were used in this investigation and both have shown good test-retest reliability, convergent and divergent validity, and internal consistency (Antony, Bieling, Cox, Enns, & Swinson, 1998).

The **Areas of Disagreement Questionnaire** (ADQ; Margolin, 1983) asks couples to rate their disagreement on 13 topics (e.g., finances, in-laws, household duties) in terms of a) how much of an issue this had been for them (from 0 – 100% of the time) and b) how long they had been disagreeing about it (weeks, months, or years). Areas of mutual disagreement were suggested as discussion topics during the conflict task. This measure has been similarly used in other investigations of couple conflict and CVR (Smith et al., 2009).

The **Marital Satisfaction Inventory - Revised** (MSI-R; Snyder, 1997) is a 150-item, true-false, self-report measure that assesses multiple relationship domains. The global distress and recently validated subscales of disharmony (i.e., conflict) and disaffection (i.e., low warmth) (Herrington et al., 2008) were used. Using normative data, disaffection scores of 2.4 or higher are considered in the distressed range, as are disharmony scores of 5.8 or higher (Herrington et al., 2008). The MSI-R has been well validated in multiple samples (Snyder, 1997).

A 12-item, adapted version of the self-report **State-Trait Personality Inventory** (STPI; Spielberger, 1980) was used to assess state anxiety and anger. This version has shown reliability and validity in previous investigations (e.g., Nealey-Moore et al., 2007).

Systolic and diastolic blood pressure (SBP and DBP) were assessed using Dinamap 8100 monitors (Critikon; Tampa, FL) with an occluding cuff attached to the upper, nondominant arm. Minnesota Impedance Cardiographs (Model HIC 2000, Surcom; Minneapolis, MN) were used to assess heart rate (HR), and sympathetic and parasympathetic functioning (i.e., PEP, hf-HRV), via continuous electrocardiogram (ECG), basal thoracic impedance (Zo), and the first derivative of the impedance signal (dZ/dt) measurements throughout the baseline period and disagreement task. Signals were processed according to standard guidelines (Sherwood et al., 1990; Thayer, Hansen, Saus-Rose, & Johnsen, 2009).[2] For additional details, see Smith et al. (2009).

Procedure

The University of Utah and Salt Lake City Veterans Affairs Medical Center (VAMC) Institutional Review Board approved the study protocol. Participants completed written, informed consent prior to participating. PTSD group couples were recruited through the Salt Lake City VAMC and postdeployment workshops. Control group couples were recruited through the same postdeployment workshops or other state-funded workshops for recently returned veterans and their families. Couples recruited through such workshops completed screening questionnaires to determine eligibility. PTSD group participants recruited through the VAMC completed telephone screenings, and a medical

[2] Stroke volume was used to calculate CO, while TPR was calculated from estimates of mean arterial pressure (MAP) and CO (TPR = MAP/CO x 80; Sherwood et al., 1990).

record chart review of the veterans' initial PTSD evaluation was also conducted, when available.

Questionnaires. Each partner completed self-report questionnaires prior to their laboratory session, including the background information questionnaire, ADQ, MSI-R, DASS, PCL-M, PCL-C, and MSCRP. Laboratory procedures were modeled closely after a previous investigation on couple interaction and CVR (Smith et al., 2009). A master's level clinician was present throughout the study protocol and a licensed psychologist was either on-call or present to intervene in cases of psychological emergency. There was one incident in which the on-call psychologist was consulted; please see the *interviewing and debriefing* section below for details.

Baseline measures. Upon arriving for their sessions, couples completed a 10-minute resting baseline task in which they sat facing one another, separated by a partition. The baseline task entailed listening to an audiotape prompting them to look through landscape pictures in a binder (c.f., Smith et al., 2009). Blood pressure was recorded every 90 seconds, and impedance cardiography signals were recorded continuously. The values of each physiological measure during the final 3 minutes were averaged to form baseline values. After the baseline, couples completed the STPI to measure resting state anxiety and anger; the partition was then removed.

Disagreement task. ADQ topics with the highest combined level of disagreement were suggested for discussion, and couples were instructed to select a topic that was a current issue that they could discuss, together, for the full period (cf. Smith et al., 2009). The task was divided into three segments. During the first, couples engaged in a 6-minute, unstructured conversation about the chosen topic. During the second, audiotaped

instructions directed the couple through an additional 8 minutes of discussing the topic, with spouses taking turns speaking at 80-second intervals. Speaking order (i.e., veteran vs. partner first) was counterbalanced across couples. The final segment consisted of an additional 3-minute, unstructured discussion of the topic. Blood pressure measurements were taken every 90 seconds during the first and last segments and every 80 seconds during the turn-taking segment. For each physiological measure, four averages were calculated: initial unstructured period, speaking, listening, and the second unstructured period.

Interviews and debriefing. Next, veterans and partners participated in structured interviews, conducted separately. All participants completed the SCID-I, and veterans also completed the CAPS. Partners were then debriefed separately to address questions or concerns and to conduct safety assessments. In one case, issues of suicidality and safety to return home arose; this participant was deemed safe to return home after a full risk assessment and consultation with the on-call psychologist. If individuals were interested in individual or couples-based mental health services, they were provided with referral information within the Salt Lake City VA healthcare system and the greater community.

Analytic Plan

Multivariate analysis of variance (MANOVA) was used to (a) compare PTSD symptom levels on the PCL-M, MSCRP, and CAPS between PTSD and control group veterans; (b) test PTSD group differences on the remaining symptom measures (DASS-D, -A, and PCL-C) and baseline levels of anger/anxiety (STPI) in both veterans and their partners; and (c) test group differences in relationship quality via the MSI-R subscales. Effects sizes are reported as η^2.

A mixed analysis of variance (ANOVA) was used to test PTSD group differences on baseline hf-HRV and PEP in veterans and their partners. PTSD diagnosis was treated as a between-subjects factor (Couple Type: PTSD vs. Control), whereas veterans and partners were treated as two levels of a repeated factor (Role: veteran vs. partner) to accommodate dependency in their responses (i.e., participants nested within couples). This analysis permitted comparisons of both PTSD vs. control and veterans vs. partners. Mean comparisons following significant F-tests in the mixed ANOVA used the appropriate error term (Bernhardson, 1975).

To test responses to the conflict discussion task, change scores (i.e., task value minus baseline) were used (Llabre, Spitzer, Saab, Ironson, & Schneiderman, 1991). A similar mixed ANOVA was used to test physiological responses to the disagreement task, but was expanded to include a second repeated factor representing the four task periods (i.e., Period: first unstructured period, speaking, listening, second unstructured period). For effects involving the task period factor, significance levels were adjusted appropriately (Greenhouse & Geisser, 1959). A similar mixed ANOVA was used for veterans' and partners' affective responses to the discussion (i.e., task minus baseline change score), but in addition to the repeated factor for veterans versus partners, a second repeated factor was included for Affect Type (i.e., anger vs. anxiety). This permitted a test of the relative magnitude of anger versus anxiety responses to the task.

Table 1.

Demographic and Service-Related Characteristics

	Control (N = 33 couples)		PTSD (N = 32 couples)	
	Veterans	Partners	Veterans	Partners
Education (%)				
No or Some High School	0	0	0	9.4
High School Degree/GED	6.1	3.0	25	31.3
Some College/Associate's Degree	48.5	69.7	62.5	37.5
Bachelor's Degree	39.4	24.2	9.4	9.4
Master's Degree or Higher	6.1	3.0	3.1	12.5
Deployment Location (%)				
Iraq	56.3		71.9	
Afghanistan	25		12.5	
Both	18.8		15.6	
Branch of Service (%)				
Army	84.4		71.0	
Marines	0		21.4	
Navy	0		3.6	
Air Force	15.6		3.6	
Active Duty (%)	15.6		50	
National Guard (%)	75		29.2	
Reserves (%)	9.4		20.8	

Note. PTSD = posttraumatic stress disorder.

RESULTS

Group Differences in PTSD and General Emotional Adjustment

A MANOVA of veterans' total scores on the PCL-M, MSCRP, and CAPS indicated that the PTSD group reported greater PTSD symptoms than did control group veterans, $F(3, 60) = 142.37$, $p < .001$, $\eta^2 = .88$. Means and univariate tests are presented in Table 2. Veterans in the PTSD group endorsed moderate to severe PTSD symptoms (Blake et al., 1995b; Keane, Caddell, & Taylor, 1988; Weathers, Litz, Herman, Huska, & Keane, 1993), while control group veterans reported symptoms below a clinical range. MANOVAs of veterans' and partners' scores on the DASS-D, DASS-A, baseline (i.e., resting) state anger and anxiety subscales of the STPI, and PCL-C (partners only) revealed that, both veterans, $F(4, 62) = 36.10$, $p < .001$, $\eta^2 = .71$, and partners, $F(5, 63) = 6.63$, $p < .01$, $\eta^2 = .36$, in the PTSD group reported greater psychological distress than those in the control group. Veterans in the PTSD group endorsed clinical levels of depression and general anxiety, whereas control group veterans' scores on these measures were not in a clinical range (Antony, Bieling, Cox, Enns, & Swinson, 1998). Although partners' averages for depression and anxiety did not reach clinical severity for either group, partners in the PTSD group endorsed a higher level of these symptoms than control partners (see Table 2). Veterans and partners in the PTSD group reported higher levels of state anger and anxiety than in the control group, although these effects were stronger for anxiety than anger.

Couple Functioning

A MANOVA of veterans' and partners' MSI-R Global Distress, Disaffection, and Disharmony scale scores revealed that, overall, PTSD group couples reported greater couple distress than did control couples, $F(6, 63) = 8.10$, $p < .001$, $\eta^2 = .46$. Means and univariate tests are presented in Table 3. The control couples' average scores were well within the normal range on all three scales, whereas averages for veterans and partners in the PTSD group were in the moderately distressed range (Herrington et al., 2008; Snyder, 1997). This group difference between PTSD and control couples was substantially larger for the Disharmony scale than the Disaffection scale ($\eta^2 = .38$ vs. .19). Hence, couples with PTSD reported generally greater distress, but were particularly distinguished by high levels conflict compared to significant, but somewhat lessor, problems related to closeness and warmth. Analyses treating veterans and partners as a repeated factor in mixed ANOVAs of each couple adjustment measure did not produce any significant partner effects or any significant Couple Type x Role (veteran vs. partner) interactions (all ps > .20). Hence, the elevated relationship distress reported by PTSD couples was similar for veterans and their partners (see Table 3).

Negative Affect During the Conflict Task

The Couple Type X Role X Negative Affect Type (i.e., anger vs. anxiety) ANOVA of negative affect responses to the conflict task revealed an overall increase in negative affect over baseline levels, $F(1, 63) = 89.77$, $p < .001$, $\eta^2 = .59$, and the increase in anger (3.73, $SE = .44$) was greater than the increase in anxiety (2.50, $SE = .32$), $F(1, 63) = 9.97$, $p < .01$, $\eta^2 = .14$. Further, female partners reported somewhat larger increases in overall negative affect than did the male veterans, although this difference only

approached significance, $F(1, 63) = 3.74$, $p = .058$, $\eta^2 = .056$. As depicted in Figure 1, a main effect of Couple Type indicated that overall PTSD couples reported larger increases in negative affect than did control couples (4.65 vs. 1.57; *SE* = .47, .46, respectively), $F(1, 63) = 21.94$, $p < .001$, $\eta^2 = .26$. A Couple Type X Affect Type interaction, $F(1, 63) = 12.46$, $p < .001$, $\eta^2 = .16$, indicated that although PTSD couples reported more negative affect than control couples in the case of both anxiety (3.34 vs. 1.65; *SE* = .45, .44), $t(63) = 2.32$, $p < .05$, and anger (5.95 vs. 1.50; *SE* = .62, .62), $t(63) = 6.12$, $p < .001$, the increase in anger was significantly larger than the increase in anxiety, $t(63) = 3.59$, $p < .001$. (For descriptive purposes, the effect size for the Couple Type main effect was $\eta^2 = .29$ versus .10 for anger and anxiety, respectively, when these affects were tested separately). The interactive effect was due largely to the fact that, when considered separately, both veterans and their partners in PTSD couples reported significantly larger increases in anger than anxiety, both $t(63) > 2.75$, $p < .01$. In contrast, control couples reported smaller and equivalent increases in anxiety and anger.

Baseline Autonomic Functioning

The mixed ANOVA of resting hf-HRV revealed a Role X Couple Type interaction, $F(1, 60) = 8.57$, $p < .01$, $\eta^2 = .12$. Veterans with PTSD displayed lower levels of resting hf-HRV (5.3, *SE* = .22) than control veterans (6.1, *SE* = .21) or PTSD partners (5.9, *SE* = .20) (*p*s < .05). The latter two groups did not differ from each other, or from the control partners (5.8, *SE* = .20). The mixed ANOVA of baseline PEP revealed no significant effects. Hence, PTSD was associated lower levels of parasympathetic tone, but not with higher sympathetic tone.

Cardiovascular Responses to Conflict Task

Systolic blood pressure. The Couple Type X Role X Periods mixed ANOVA indicated that SBP was elevated 10.2 mmHg over baseline levels during the task, $F(1, 63) = 163.8$, $p < .001$, $\eta^2 = .72$. Also, compared to male veterans, female partners displayed greater SBP responses (7.3 mmHg vs. 13.0 mmHg; $SE = .85, 1.05$, respectively), $F(1, 63) = 28.58$, $p < .001$, $\eta^2 = .31$. PTSD couples displayed larger SBP responses than control couples (11.9 mmHg vs. 8.4 mmHg; $SE = 1.1, 1.1$), $F(1, 63) = 5.03$, $p < .05$, $\eta^2 = .074$. The magnitude of this effect of Couple Type was not significantly different between veterans and partners, Couple Type X Role interaction $F(1, 63) = 0.41$, $p = .53$, $\eta^2 = .006$, and as depicted in Figure 2 the Couple Type effect was significant for both veterans, $t(63) = 2.68$, $p < .01$, and partners, $t(63) = 3.93$, $p < .01$. Finally, a Couple Type X Periods interaction, $F(3, 189) = 3.17$, $p < .05$, $\eta^2 = .05$, indicated that although the effect of couple type was significant across all four task periods, it was largest during the initial unstructured period (11.5 mmHg; $SE = 1.2$ vs. 8.7 mmHg; $SE = 1.2$) and while participants were talking (14.4 mmHg; $SE = 1.3$ vs. 8.8 mmHg; $SE = 1.3$).

Diastolic blood pressure. The mixed ANOVA indicated that DBP was elevated 5.9 mmHg above baseline during the task, $F(1, 63) = 172.9$, $p < .001$, $\eta^2 = .73$. The Couple Type X Role interaction approached significance, $F(1, 63) = 3.04$, $p = .086$, $\eta^2 = .046$. The partners of veterans with PTSD displayed larger increases in DBP during the task (7.4 mmHg; $SE = .89$) than did the partners of veterans without PTSD (4.9 mmHg; $SE = .88$), $t(63) = 3.46$, $p < .001$. Within PTSD couples, partners also displayed larger increases than did veterans (5.5. mmHg; $SE = .83$), $t(63) = 2.7$, $p < .01$. Veterans with PTSD did not differ from veterans in control couples (5.8 mmHg; $SE = .81$), and veterans

and their partners in control couples did not differ.

Heart rate. The mixed ANOVA indicated that HR was elevated by 2.4 bpm over baseline during the task, $F(1, 59) = 37.78$, $p < .001$, $\eta^2 = .39$. Compared to veterans, partners displayed greater HR responses to the task (3.6 bpm vs. 1.5 bpm; *SE* = .58, .43, respectively), $F(1, 59) = 11.32$, $p = .001$, $\eta^2 = .16$. In a significant Role X Periods interaction, $F(3, 177) = 3.81$, $p < .05$, $\eta^2 = .061$, partners had larger HR responses than veterans during all periods, but this difference was larger during the initial unstructured (4.4 bpm vs. 2.4 bpm; *SE* = .64, .45, respectively) and talking periods (6.1 bpm vs. 2.8 bpm; *SE* = .75, .54) than the listening period (1.1 bpm vs. -.48 bpm; *SE* = .59, .53). There were no significant Couple Type or Role X Couple Type effects for HR (all *p*s > .12)

High frequency heart rate variability. The ANOVA of hf-HRV changes during the task revealed no significant effects, although there was a small increase over baseline levels during the task (.16), $F(1, 60) = 12.7$, $p < .001$, $\eta^2 = .17$.

Cardiac preejection period. The mixed ANOVA indicated expected and significant increases in cardiac sympathetic activation during the task (i.e., PEP shortening; -2.41 msec), $F(1, 57) = 24.02$, $p < .001$, $\eta^2 = .30$. Partners displayed greater PEP responses to the task, compared to veterans (-3.32 msec vs. -1.49 msec; *SE* = .65, .63, respectively), $F(1, 57) = 5.08$, $p < .05$, $\eta^2 = .062$. In addition, PTSD couples displayed larger PEP responses than did control couples (-3.45 msec vs. -1.36 msec; *SE* = .71, .68), $F(1, 57) = 4.57$, $p = .037$, $\eta^2 = .066$. That is, partners displayed greater sympathetic activation (i.e., PEP shortening) during the conflict discussion than did veterans, and PTSD couples displayed greater sympathetic response than did control couples. The Couple Type X Role interaction was not significant, $F(1, 57) = 1.62$, $p =$

.21, η^2 =.028. However, as seen in Figure 2, the effect of Couple Type on sympathetic responses to the task were not parallel for veterans and partners. Specifically, veterans with PTSD displayed significantly greater sympathetic activation than control veterans, $t(57) = 4.33$, $p < .001$, whereas the effect of Couple Type was not significant among partners. Further, although partners displayed greater sympathetic activation than veterans in control couples, $t(57) = 3.97$, $p < .001$, veterans and partners in the PTSD group displayed similar sympathetic responses.[3] Thus, the aforementioned overall effect of Couple Type on sympathetic activation was likely due to the pronounced difference between veterans with PTSD versus control veterans.

[3] A Couple Type X Periods interaction revealed that PTSD couples showed larger increases in CO during the initial portion of the task (.70 l/min) than at the end (-.13 l/min), whereas control couples showed intermediate increases in CO across the task (.34 l/min, .21 l/min), $F(3, 168) = 4.29$, $p = .006$, $\eta^2 = .07$. Although it only approached significance, ($F(1, 53) = 3.59$, $p = .064$, η^2 =.06), PTSD couples demonstrated a non-significant change in TPR from baseline through the task (-26.4), whereas control couples demonstrated significantly increased TPR (240.63). This suggests that PTSD couples' greater SBP reactivity reflected increased CO, rather than TPR.

Table 2.

Main Effects of PTSD and Psychological Distress Symptoms

	Mean (*SE*)		*F* (*df*)	*p*	η^2
	Control	PTSD			
PTSD					
CAPS (Veteran)	4.26 (2.74)	72.45 (2.74)	308.79	.000	.84
MSCRP (Veteran)	54.83 (2.29)	112.84 (2.29)	321.85	.000	.84
PCL-M (Veteran)	19.65 (1.53)	59.10 (1.53)	334.46	.000	.85
PCL-C (Partner)	20.24 (2.00)	34.22 (2.00)	24.76	.000	.28
General Anxiety (DASS-A)					
Veteran	.82 (.81)	13.71 (.84)	121.52	.000	.66
Partner	1.46 (.90)	5.09 (.91)	8.07	.006	.11
Depression (DASS-D)					
Veteran	1.03 (1.31)	18.39 (1.3)	85.59	.000	.58
Partner	1.55 (1.26)	8.90 (1.28)	16.61	.000	.21
State Anger (STPI)					
Veteran	7.52 (.37)	9.77 (.38)	17.96	.000	.23
Partner	7.24 (.27)	8.00 (.27)	3.92	.052	.06
State Anxiety (STPI)					
Veteran	7.36 (.47)	11.74 (.48)	42.64	.000	.41
Partner	8.00 (.56)	11.03 (.57)	14.49	.000	.19

Note. PTSD = posttraumatic stress disorder; CAPS = Clinician Administered PTSD Scale; MSCRP = Mississippi Scale for Combat-related PTSD; PCL-M, - C = PTSD Checklist – Military, -Civilian; DASS-A, -D = Depression Anxiety Stress Scale – Anxiety, - Depression; STPI = State Trait Personality Inventory.

Table 3

Effects of PTSD on Couple Distress

	Mean (*SE*)		*F* (1,63)	*p*	η^2
	Control Group	PTSD Group			
Global Distress					
Veteran	47.06 (1.53)	59.20 (1.56)	31.15	.000	.33
Partner	47.79 (1.40)	57.88 (1.43)	25.41	.000	.29
Disaffection					
Veteran	.79 (.47)	2.53 (.48)	6.83	.011	.10
Partner	.55 (.38)	2.85 (.38)	18.20	.000	.22
Disharmony					
Veteran	2.76 (.41)	6.06 (.42)	31.73	.000	.34
Partner	3.09 (.44)	6.18 (.45)	23.89	.000	.28

Note. PTSD = posttraumatic stress disorder.

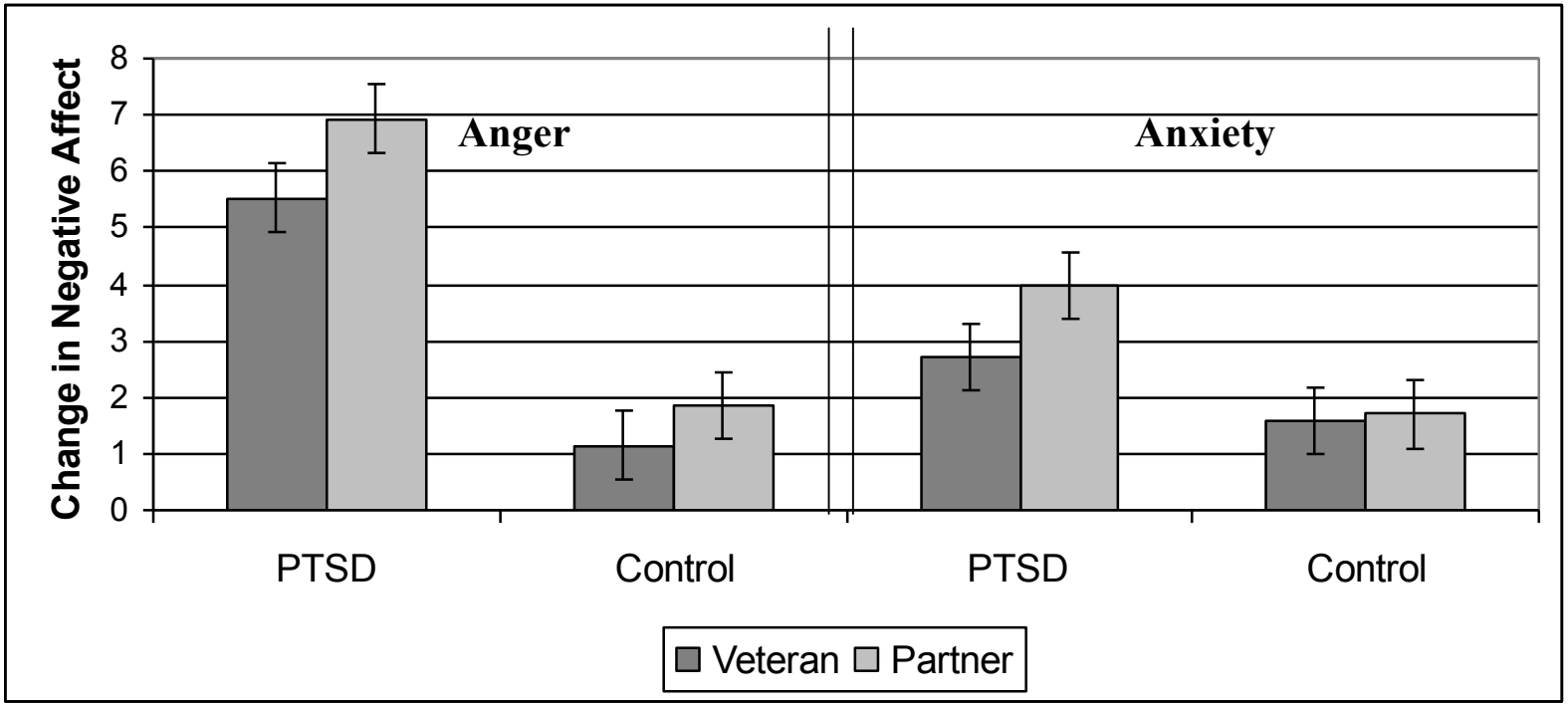

Figure 1.

Increases in self-reported anger and anxiety during couple disagreement discussion.

Note. PTSD = posttraumatic stress disorder.

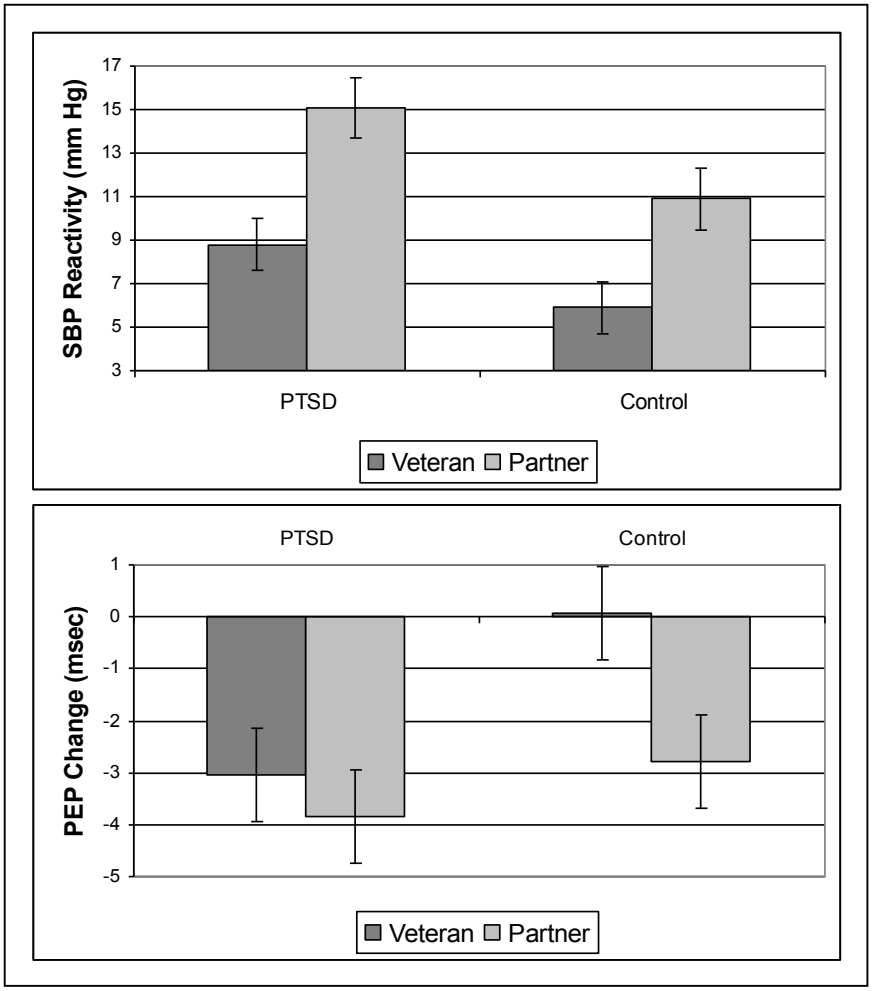

Figure 2.

Systolic blood pressure and pre-ejection period reactivity in response to couple disagreement discussion.

Note. PTSD = posttraumatic stress disorder; SBP = systolic blood pressure; PEP = pre-ejection period.

DISCUSSION

PTSD is associated with increased risk for cardiovascular disease (CVD). Greater exposure to couple conflict and greater cardiovascular reactivity (CVR) to such conflict may be important pathways linking PTSD to CVD. The role of relationship discord and related physiological responses in CVD has been explored generally, but not in PTSD or in military samples. Further, although a growing body of literature highlights the psychological risks for partners of veterans with PTSD, no study has examined the potential health risks for these individuals. The present study addressed these issues, by assessing multiple aspects of couple functioning and emotional and cardiovascular responses to couple conflict in Operations Enduring and Iraqi Freedom (OEF/OIF) veterans, with and without PTSD, and their partners.

Results indicated that veterans and partners in the PTSD group reported greater emotional distress than control couples, in the form of PTSD symptom severity, depression, general anxiety, and state anger and anxiety. Although high anger in veterans with PTSD is well documented, increased baseline anger in their partners has not been reported previously. Results also demonstrated that both veterans and partners in the PTSD group exhibited greater reactivity in anger and anxiety in response to relationship conflict, relative to the control group. Moreover, veterans with PTSD and their partners responded to the discussion task with significantly greater increases in anger than anxiety. That is, in terms of affective responses to couple conflict, anger was a much

stronger correlate of PTSD for both veterans and their partners.

Considering the couple and cardiovascular risks conferred by anger (Baron et al., 2007; Chida & Steptoe, 2009; Sanford, 2007), heightened baseline anger and anger responses during couple disagreement place veterans with PTSD and their partners at risk for a variety of emotional, interpersonal, and physical health problems. Although treatment for PTSD reduces anger (Cahill, Rauch, Hembree, & Foa, 2003), little attention has been paid to assessing and treating anger in partners. Thus, targeting anger in *both* members of a couple could have important implications for reducing relationship discord and related risks associated with PTSD.

With regard to relationship functioning, the present results replicate and extend prior findings (Taft et al., 2011). Specifically, PTSD couples reported greater overall dissatisfaction, disharmony (i.e., conflict), and disaffection (i.e., low warmth/closeness). Importantly, the couple distress reported by the PTSD group was more characterized by high conflict than a lack of warmth or closeness. High conflict in PTSD couples is not surprising, but it is interesting that it was a greater problem than low warmth, which one might expect to be similarly problematic, considering the emotional numbing/withdrawal often observed in PTSD. The relative importance of conflict as opposed to low levels of positive involvement may have important implications for the focus of couple-based interventions. Moreover, research evaluating the relation between PTSD symptom clusters and the dimensions of disharmony and disaffection is also warranted.

In terms of baseline physiological outcomes, veterans in the PTSD group exhibited lower resting hf-HRV, compared to their PTSD group partners and veterans and partners in the control group, indicating that PTSD is associated with reduced

parasympathetic tone (c.f., Hauschildt et al., 2011). Low levels of resting hf-HRV may reflect reduced capacities for self-regulation (e.g., response inhibition, restraint, self-control), which in turn increase the likelihood of a variety of maladaptive emotional, social, and physiological responses (Porges, 2007; Thayer et al., 2009). Moreover, it is associated with both increased risk of CVD (Thayer & Lane, 2007) and greater relationship difficulties (Smith et al., 2011). Thus, our results reinforce prior studies finding lower resting hf-HRV in PTSD and further highlight this as one mechanism potentially linking PTSD with CVD risk and emotional and interpersonal difficulties in these veterans.

PTSD was also associated with physiological responses to the conflict task. Overall, PTSD group couples displayed greater SBP responses and greater sympathetic activation (i.e., PEP shortening) to conflict than control couples. This latter effect, however, was largely due to the fact that veterans with PTSD displayed significant sympathetic reactivity to the task, whereas control veterans did not. If repeated frequently, the SBP response and cardiac sympathetic reactivity to couple conflict displayed by veterans with PTSD could contribute to the association of PTSD with CVD, especially considering the high prevalence and severity of relationship discord in this population. These cardiovascular stress responses can promote chronic elevations in blood pressure, hasten the development and progression of atherosclerosis, and contribute to the precipitation of acute cardiovascular events (e.g., myocardial infarction or "heart attack") among persons with underlying cardiovascular disease (Chida & Steptoe, 2010).

Contrary to Hauschidlt and colleagues (2011), we did not find evidence of greater decreases in hf-HRV in response to the stressor among veterans with PTSD. However, it

is important to note that couple disagreement does not necessarily result in lowered hf-HRV (Nealey-Moore et al., 2007; Smith et al., 2009). The couple conflict task may have been less arousing than the trauma-stimuli Hauschidlt et al. (2011) utilized. Also, regulatory effort during the task may have raised hf-HRV (Smith et al., 2011), offsetting stress-related decreases. [4]

Our findings are particularly novel and important in regards to the physiological reactivity of partners. Overall, female partners displayed greater CVR (e.g., increases in SBP and HR) and sympathetic activation (i.e., PEP shortening) in response to the conflict task than male veterans. This general pattern of sex differences in physiological response to stressful couple interactions has often (Kiecolt-Glaser & Newton, 2001; Smith, Uchino et al., 2012) – but not always (Nealey-Moore et al., 2007; Smith et al., 2009) – been seen in prior studies. Of particular importance to this population, however, is that the physiological correlates of PTSD were in some instances more apparent in partners than the veterans with PTSD themselves. For instance, partners in the PTSD group displayed significantly greater SBP and DBP reactivity not only as compared to the control group partners, but also as compared to the veterans with PTSD. Hence, in some respects, the physiologic costs of PTSD during relationship disagreements may be greater for partners than the veterans themselves, with the same mechanisms potentially increasing risk for cardiovascular disease in those partners. These findings highlight the clear need for further research on the health consequences of PTSD among veterans *and* their partners.

There are several limitations that should be considered when interpreting these

[4] Although strong group differences did not emerge, means for CO and TPR changes during the task suggest that the greater blood pressure reactivity displayed by PTSD couples likely reflected increased CO as opposed to TPR.

results. First, the cross-sectional study design prevents causal inferences regarding associations among PTSD, couple discord, and responses to the interaction task. The sample exclusively consisted of male veteran/female partner couples. Thus, it is unknown whether the results of this investigation would generalize to either female veteran/male partner dyads or to same-sex couples. Moreover, the majority of participants in this sample were Caucasian. Hence, results should be replicated in more diverse samples. Also, although couples in this study demonstrated expected changes in affect and physiology during the conflict, laboratory interactions certainly differ from those in real-life settings. A more naturalistic study design could produce different findings. Moreover, although CVR has been linked to CVD, this mechanism remains tentative and health implications of the physiological effects seen here are not clearly established.

Despite these limitations, the results of this investigation have a number of implications for future research and clinical practice. First, these results extend prior models of PTSD and physical health by adding the additional pathways of exposure and physiological reactivity to couple conflict. Additional consideration of couple processes could provide a more complete approach to understanding and reducing the health risks associated with PTSD.

Although prior studies have clearly established a high prevalence of couple discord among veterans with PTSD, this study suggests that elevated levels of conflict rather than low levels of warmth, and pronounced anger during couple disagreements as opposed to anxiety aroused during such conflicts may be particularly important foci of couple assessment and intervention in PTSD. Recent evidence of the efficacy of cognitive-behavioral conjoint therapy for PTSD (Monson et al., 2012) will likely increase

consideration of couples issues and interventions in the treatment of PTSD. Our results suggest that a particular emphasis on anger and conflict may be useful, and that the benefits of such interventions could go beyond improved emotional and relationship functioning to include reduced health risks, as well. Future research may consider physiological outcomes in response to treatment, as an avenue for exploring these potential benefits further.

Our results also suggest that partners of veterans with PTSD are at risk not only for emotional and relationship problems, but also physical health problems. These data add to the rapidly accumulating literature on the consequences of PTSD for veteran's families. As we develop new ways to treat the range of problems that OEF/OIF veterans confront, it is important to attend to the effects of war on the families of veterans, as they also clearly suffer as a result of military and PTSD-related strains.

Overall, results from this investigation highlight the potential role of couple difficulties in the increased risk for cardiovascular disease among OEF/OIF veterans with PTSD, while also suggesting the possibility of similar health risks for their partners. Anger and couple conflict may be a particularly useful focus in research and applications regarding the various effects of PTSD on health and well-being. Further research on these issues could provide a better understanding of relationship and health risks for military families and couples, and may provide additional opportunities for prevention and management of broadly-defined health issues in this population.

APPENDIX

PROPOSED ANALYSES NOT INCLUDED IN MANUSCRIPT

- Several other MSI-R subscales of Affective Communication, Problem-Solving Communication, Aggression, Time Together, and Sexual Dissatisfaction were also used in this investigation. The Affective Communication subscale assesses dissatisfaction with the amount of understanding and affection that one's partner expresses. Problem-Solving Communication examines areas of discord in relation to resolving differences. The Aggression subscale assesses the extent of intimidation and physical aggression present within the relationship. The Time Together subscale examines dissatisfaction with shared leisure time and a lack of common interests. Finally, the Sexual Dissatisfaction subscale examines level of dissatisfaction with the frequency and quality of sexual intercourse and sexual intimacy (Snyder, 1997).

- A MANOVA of veterans' and partners' scores on these MSI-R subscales revealed that, overall, PTSD group couples reported greater marital distress than did control couples, $F(10, 62) = 5.98$, $p < .001$, $\eta^2 = .53$.

    - For efficiency, we report the Couple Type effects combining veterans' and partners' reports, although the effects were highly similar when considered independently. Means and univariate tests are presented in Table 4.
    - Although PTSD couples reported significantly greater distress across all these domains, the largest couple type differences occurred for Affective Communication, $F(1,62) = 48.6$, $p < .001$; $\eta^2 = .44$, and Problem-Solving Communication, $F(1,63) = 44.3$, $p < .001$; $\eta^2 = .41$; the smallest couple type differences occurred for Time Together, $F(1,63) = 17.3$, $p < .001$; $\eta^2 = .22$, and Sexual Dissatisfaction, $F(1,63) = 15.5$, $p < .001$; $\eta^2 = .20$.
      The intermediate effect size for the Aggression scale, $F(1,63) = 25.7$, $p < .001$; $\eta^2 = .29$, suggests that the high levels of marital distress and conflict reported by PTSD couples is not necessarily accompanied by similarly pronounced differences in reported levels of frank aggressive behavior, although there was a large difference on this scale and the mean scores for PTSD couples were moderately elevated over control couples (55.11 vs. 47.23; $SE = 1.12, 1.09$, respectively).

- The Impact Message Inventory – Circumplex (IMI-C; Kiesler, Schmidt, & Wagner, 1997) is a 32-item, Likert-type, self-report measure derived from the interpersonal circumplex's dimensions of affiliation (i.e., friendliness vs. hostility) and control (i.e.,

dominance vs. submissiveness; Kiesler, 1983). This measure was also completed by both veterans and spouses in regard to their behavior during typical couple interactions and during the disagreement task.

- A MANOVA of veterans' and partners' ratings of their partners' affiliation and control during typical couple interactions indicated that PTSD couples rated their partners as lower in affiliation (i.e., more hostile) and higher in control (i.e., more dominant, less deferent), $F(4,60) = 9.46, p < .001, \eta^2 = .39$. Means and univariate tests are presented in Table 4.

- A Couple Type X Spouse mixed ANOVA of spouse ratings of affiliation during the conflict discussion indicated that PTSD couples rated each other as displaying less warmth (i.e., more hostility) than did control couples (1.04 vs. 3.85; SE = .35, .34), $F(1,62) = 33.25, p < .001, \eta^2 = .35$.

- A similar mixed ANOVA of IMI-C ratings of spouses' control (i.e., dominance vs. submissiveness) indicated that PTSD couples rated their partners as being more dominant during the conflict discussion, $F(1, 62) = 7.03, p = .01, \eta^2 = .102$. Hence, the overall subjective experience during the conflict discussion was such that PTSD couples found their partners to be less warm and more controlling than did control couples.

Table 4

Veterans' and Partners' Marital Satisfaction Inventory Subscale Scores and Impact Message Inventory Affiliation and Control Scores for General Marital Interactions

	Mean (*SE*)		*F*(1,62)	*p*	η^2
	Control	PTSD			
Affective Communication					
Veteran	44.53 (1.47)	58.12 (1.47)	42.84	.000	.41
Partner	46.19 (1.59)	57.25 (1.59)	24.20	.000	.28
Problem-Solving Communication					
Veteran	46.41 (1.66)	58.09 (1.66)	24.70	.000	.28
Partner	45.94 (1.49)	58.84 (1.49)	37.45	.000	.38
Aggression					
Veteran	48.75 (1.53)	55.19 (1.53)	8.82	.004	.12
Partner	45.91 (1.35)	55.03 (1.35)	22.91	.000	.27
Time Together					
Veteran	45.69 (1.69)	54.69 (1.69)	14.12	.000	.19
Partner	44.88 (1.70)	53.12 (1.70)	11.72	.001	.16
Sexual Dissatisfaction					
Veteran	44.25 (1.76)	50.75 (1.76)	6.80	.011	.10
Partner	43.72 (1.55)	52.36 (1.55)	15.57	.000	.20
Affiliation in General					
Veteran	4.10 (.33)	1.72 (.34)	25.46(1,63)	.000	.29
Partner	4.24 (.37)	1.15 (.38)	34.08(1,63)	.000	.35
Control in General					
Veteran	-.76 (.24)	.26 (.25)	8.53(1,63)	.005	.12
Partner	-.34 (.22)	.34 (.22)	4.74(1,63)	.033	.07

Note. PTSD = posttraumatic stress disorder.

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